WASTE MINIMIZATION/
POLLUTION PREVENTION PROGRAM PLAN
for the
STANFORD LINEAR ACCELERATOR CENTER

Prepared by the Environment, Safety and Health Division
Stanford Linear Accelerator Center
2575 Sand Hill Road
Menlo Park, California 94025

June 10, 1997

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Executive Summary

The purpose of this Waste Minimization and Pollution Prevention Program Plan (the Plan) is to identify, evaluate, and develop practicable measures to reduce the generation of nonhazardous (or municipal landfill) waste, hazardous waste, low level radioactive and mixed wastes, and to reduce usage of toxic chemicals at the Stanford Linear Accelerator Center (SLAC). The Plan is intended to document SLAC's waste minimization and pollution prevention program and discusses activities and measures to reduce wastes and to minimize pollutant releases from all environmental media in various operations and activities. The Plan has been prepared to meet federal requirements (under the Resource Conservation and Recovery Act), state requirements (under the California Hazardous Waste Source Reduction and Management Review Act of 1989), and DOE requirements (under DOE Order 5400.1). The Plan also provides how SLAC intends to meet U.S. Department of Energy (DOE) waste reduction goals.

The Plan is developed with the following benefits in mind:

- Increase protection of public health and the environment
- Reduce waste management and compliance costs
- Reduce resource usage
- Maintain or improve product/service yields where applicable
- Reduce or eliminate inventories and releases of hazardous substances
- Reduce or eliminate liabilities under environmental laws

Where technically and economically feasible, SLAC will strive to improve the probability of achieving the above benefits. SLAC's approach to meeting these objectives is to use low-capital measures in the planning and implementation of waste minimization and pollution prevention opportunities. By using low-capital measures, SLAC increases opportunity to implement waste reductions that will provide a return (in less than three years) by reducing waste management costs. Where appropriate, SLAC will make requests to DOE-OAK for funding of waste reduction projects with potential return-on-investment (ROI).

Under the May 3, 1996 DOE Secretary Goals Memorandum, sites are to set waste reduction goals for routine wastes to be achieved by December 31, 1999 using 1993 as a baseline year. The goals are:

- 33 percent reduction in the generation of nonhazardous or municipal landfill waste

- 50 percent reduction in the generation of hazardous waste

- 50 percent reduction in the generation of low level radioactive waste

- 50 percent reduction in the generation of low level mixed waste

- 50 percent reduction in toxic chemical releases and off-site transfers

Nonhazardous Waste
SLAC has achieved as high as 26 percent recycling of cardboard, office papers, beverage containers, and garden waste. Based on a survey by SLAC and Lawrence Livermore National Laboratory (LLNL) of SLAC municipal waste in site dumpsters in December 1996, most of the waste included bathroom paper towels, food wastes, and recyclable cardboard and paper. It is estimated that recyclable paper and cardboard constitute about 30 tons or 5 percent of the total nonhazardous waste disposed to landfill. Assuming SLAC could add this quantity to its existing quantity of recycled materials, SLAC can achieve 30 percent recycling excluding scrap metals. SLAC scrap metal recycling has been variable; however, assuming a comparable generation of scrap metal in future years similar to 1996, SLAC may achieve 55 percent recycling of nonhazardous waste. This recycling goal excludes nonroutine wastes or those generated on a one-time basis.

Hazardous Waste
Based on evaluation of potential waste reductions and 1996 hazardous waste generation data, it is estimated that SLAC can meet a waste reduction of approximately 20,000 kilograms (22 tons) for major waste streams by the following measures:

- Reusing waste acids with and without metals by acid reuse and treatment under California's Permit-by-Rule (PBR)

- Reducing rinse water usage in Metal Finishing to reduce heavy metal filter cake by reusing deionized water

- Implementing measures to reduce waste oil and unspecified oil-containing wastes by reduced use of absorbents

- Recycling empty containers as scrap metal

It is strongly emphasized that the suggested reductions in operational hazardous waste are based on 1996 and earlier waste generation trends. The 20,000 kg reduction in operational hazardous waste will allow SLAC to achieve an overall reduction of 56 percent relative to the 1993 baseline generation rate. SLAC achievement of numerical waste reduction goals or performance objectives may not be attainable without compensation for nonroutine wastes or waste resulting from outside activities (support to other DOE laboratories).

Low Level Radioactive and Mixed Wastes

Most low level radioactive and mixed wastes are characteristically nonperiodic and are usually generated as a part of the 2-mile linear accelerator maintenance and upgrades. These materials are part of the accelerator and beamline structures, components and equipment. Normally such materials remain in the accelerator housing and tunnels, which are classified as Radioactive Material Management Areas (RMMA). When portions of the structure, components or equipment must be removed for repair or reconstruction, they are surveyed for radioactivity. Items found to be nonradioactive are released for unrestricted use and recycled. Radioactive materials are reused where possible to minimize generation of waste. When not reusable, these materials become low level radioactive or mixed wastes.

For low level radioactive and mixed wastes, some scrap metals may be ideal candidates to return to the environment for reuse because radioactive levels are extremely low and may qualify for for exemption from regulatory control. This waste reduction approach is currently being developed between SLAC and DOE Oakland Operations Office (DOE-OAK). However, it is not appropriate and too early to define goals for this waste stream at this time.

Mixed waste is characterized as both radioactive and hazardous. The general waste reduction measures that SLAC proposes for reduction of low level mixed waste are:

- Increase employee awareness and training on identifying, handling and segregating hazardous materials transferred in or out of RMMAs.

- Increase employee awareness in selecting less hazardous alternatives to replace hazardous materials.

Toxic Chemicals

A significant toxic chemical used at SLAC is 1,1,1-trichloroethane (trichloroethane). To replace trichloroethane or to further reduce its usage, SLAC has implemented three measures:

- Consolidating vapor degreasing operations into one new closed-loop vapor degreasing system designed to recycle trichloroethane or perchloroethane and significantly reduce its release to the atmosphere

- Replacing the present use of trichloroethane with a combustible petroleum distillate-based solvent and investigating on-site recycling to increase solvent reuse

- Cleaning klystron tubes assemblies by a combination of a spray-on, citrus-based solvent followed by steam-detergent wash and deionized water rinse

The first measure is critical to SLAC to assure reliability in cleaning of a vast range of parts that are subject to ultrahigh vacuum applications, thus requiring a high degree of cleanliness. The second measure helps reduce the use of trichloroethane in less critical cleaning operations. The third measure uses aqueous cleaning for a common line of parts, thus reducing the dependence on trichloroethane. SLAC is currently implementing the second and third measures. Implementation of the first method is in progress. SLAC has procured the closed-system vapor degreaser and will be installing and testing it in the next couple of years. Using these measures, it is estimated that SLAC will reduce the release and off-site transfer of trichloroethane by 80% in the next three years relative to 1993 baseline.

WASTE MINIMIZATION/POLLUTION PREVENTION PROGRAM PLAN

June 10, 1997

This document is signed and dated by a person who is capable of requesting financial resources necessary to implement the Plan. However, SLAC programs are primarily funded by the U.S. Department of Energy and constraints exist that limit the flexibility afforded to SLAC management in the use of the funds received. This document revises and replaces the SLAC November 30, 1994 Waste Minimization Program Plan to Comply with DOE Order 5400.1 (Document Identification: SLAC-I-750-3A08A-001 Rev.2) and has been reviewed, accepted, and approved for implementation by:

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Work supported by Department of Energy contract DE-AC03-76SF00515

REVISIONS LOG

DATE	REV. NO.	EXPLANATION/CONTACT

ABBREVIATIONS/ACRONYMS

CCR	**California Code of Regulations**
CP	**Charge-Parity**
CRT	**Cathode Ray Tube**
CWC	**California Waste Code**
CY	**Calendar Year**
CYO	**Cryogenics Operations Group**
DOE	**U.S. Department of Energy**
DOE-OAK	**DOE Oakland Operations Office**
DTSC	**Department of Toxic Substances Control**
EDM	**Electrical Discharge Machining**
EFD	**Experimental Facilities Department**
ELD	**Electronics Department**
EM	**Office of Environmental Restoration and Waste Management**
EPA	**U.S. Environmental Protection Agency**
ES&H	**Environment, Safety and Health Division**
FAC	**Facilities Department**
FY	**Fiscal Year**
H&S	**California Health and Safety Code**
HDPE	**High Density Polyethylene**
HVAC	**Heating, Ventilation and Air Conditioning**
KG	**Kilogram**
KLY	**Klystron/Microwave Test Laboratory**
LBNL	**Lawrence Berkeley National Laboratory**
LCW	**Low-Conductivity Water**
LLNL	**Lawrence Livermore National Laboratory**
MFD	**Mechanical Fabrication Department**
NRC	**Nuclear Regulatory Commission**
OHP	**Operational Health Physics Department**
PBR	**Permit-by-Rule**
PCB	**Polychlorinated Biphenyl**
PCD	**Power Conversion Department**
PE	**Plant Engineering Department**
PEP	**Positron-Electron Project**
PET	**Polyethylene Terephthalate**
POTW	**Publicly-Owned Treatment Works**
PRC	**Property Control Department**
RCRA	**Resource Conservation and Recovery Act**
RMMA	**Radioactive Materials Management Area**

ROI	**Return-on-Investment**
RWTF	**Rinse Water Treatment Facility**
S&R	**Shipping and Receiving Department**
SARA	**Superfund Amendments and Reauthorization Act**
SB	**Senate Bill**
SBSA	**South Bayside System Authority**
SLAC	**Stanford Linear Accelerator Center**
SLC	**Stanford Linear Collider**
SLD	**SLAC Large Detector**
SHA	**Safety, Health and Assurance Department**
SPEAR	**Stanford Positron Electron Asymmetric Ring**
SSRL	**Stanford Synchrotron Radiation Laboratory**
TSCA	**Toxic Substances Control Act**
TRI	**Toxic Chemical Release Inventory**
TSD	**Treatment, Storage and Disposal Facility**
WBSD	**West Bay Sanitary District**
WM	**Waste Management Department**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. Plan Purpose and Scope

The purpose of this Waste Minimization and Pollution Prevention Program Plan (the Plan) is to identify, evaluate, and develop practicable measures to reduce the generation of nonhazardous (or municipal landfill) waste, hazardous waste, low level radioactive and mixed wastes, and to reduce usage of toxic chemicals at the Stanford Linear Accelerator Center (SLAC). The Plan is intended to document SLAC's waste minimization and pollution prevention program and discusses activities and measures to reduce wastes and to minimize pollutant releases from all environmental media in various operations and activities. The Plan has been prepared to meet federal requirements (under the Resource Conservation and Recovery Act), state requirements (under the California Hazardous Waste Source Reduction and Management Review Act of 1989), and DOE requirements (under DOE Order 5400.1). The Plan also provides how SLAC intends to meet U.S. Department of Energy (DOE) waste reduction goals (discussed in Section 3).

Under the DOE Work Smart standards, and federal and state regulations, SLAC is required to have a plan which identifies measures to reduce hazardous wastes and prevent pollution. DOE further requires each of its sites to include measures to reduce nonhazardous waste, low level radioactive waste, and toxic chemical usage. The Plan is submitted to DOE every three years and is used by the DOE as a consideration in formulating site-specific budget requests for funding of waste minimization and pollution prevention projects and program elements. SLAC prepared its last plan for DOE on November 30, 1994 (DOE Plan, Reference 1).

The Plan also supplements the California Hazardous Waste Source Reduction and Management Review Act of 1989 (called Senate Bill 14 [SB 14]). To comply SB 14, SLAC prepares a separate plan (SB 14 Plan, Reference 2) which addresses measures to reduce hazardous waste and extremely hazardous waste sources. California specifically emphasizes that applicable facilities or organizations give preference to measures which eliminate sources of hazardous waste generation over those measures which use recycling or treatment.

SLAC reviewed its activities and waste inventories to develop waste reduction and pollution prevention goals and strategies for the next three years. Activities and trends in nonhazardous and hazardous waste generation were evaluated to determine if SLAC could achieve these goals. Waste reduction measures for low level radioactive and mixed wastes are addressed in the SLAC Radioactive Materials Program in the following key documents: Low Level Radioactive Certification Program (Reference 3), Radioactive Material Management Manual (Reference 4), and the Draft Radioactive Waste Minimization Program plan (Reference 5).

The Plan is revised and updated every three years and supersedes the November 30, 1994 DOE Plan. Copies of the most recent plan are kept on file and made available for public review in the SLAC Library (Central Laboratory, Building 40, 2nd Floor) and the Environment, Safety and Health Division (ES&H) Document Room (Building 24, 2nd Floor).

In accordance with the DOE Oakland Operations Office (DOE-OAK) guidance, the Plan is prepared with the reporting outline as provided in the Table of Contents (Letter from K. King to R. Cellamare, April 15, 1997). The Plan will be made available by DOE-OAK to the State of California to meet planning and reporting requirements under SB 14.

Section 2 of this report provides general information about the SLAC site and a description of the operations that generate nonhazardous, hazardous and low level radioactive wastes. Section 3 discusses the SLAC waste reduction goals and achievement of DOE performance objectives and how SLAC plans to achieve these goals. Section 4 provides more detailed descriptions of nonhazardous, hazardous, and radioactive waste categories and provides evaluations to identify major waste streams, those greater than 5 percent of the total operational wastes in the various waste categories, mainly for hazardous waste. Section 5 provides an evaluation of potential measures to reduce the major waste streams. Section 6 provides an evaluation of those activities that are planned to achieve the goals. Resources required and timetables to achieve these goals are provided in Section 7.

2. Site Information and Description of Operations

2.1 Site Information

Site: Stanford Linear Accelerator Center

Address: 2575 Sand Hill Road
Menlo Park, California 94025
San Mateo County

SIC Code: University SIC 8221
Type of Business Activity: High Energy Physics
Time in Business: Since 1962
Major Products: Research

Site Population (as of December 1996):

Full - time and part-time:	Approx.	1200
Visiting Scientists:	Approx.	250 to 500
Total:	Approx.	1450 to 1700

2.1.1 Site Background

SLAC is a federal facility operated by Stanford University under contract with the DOE Office of Energy Research. SLAC is a single-purpose laboratory, devoted to experimental and theoretical research in elementary particle physics, and to the development of new techniques in high-energy accelerators and elementary particle detectors. The Stanford Synchrotron Radiation Laboratory (SSRL) utilizes the SLAC facilities for research of synchrotron radiation in biology, chemistry, physics, materials science, medical science, and other disciplines.

SLAC is located in Menlo Park, California. It occupies 170 hectares (426 acres) of land located on the San Francisco Peninsula, about half way between the cities of San Francisco and San Jose in an unincorporated portion of San Mateo County (see Figure 1). It is bordered on the north by Sand Hill Road and on the south by San Francisquito Creek. The site consists of numerous buildings and structures used to house personnel and experimental equipment. The unique feature of SLAC is its 3.2-kilometer (2-mile) long linear accelerator facility[1] occupying a 300-meter wide parcel of land running

[1]Other smaller linear accelerators exist on site; however, this document will exclusively refer to the 2-mile linear accelerator. Other linear accelerators at SLAC or SSRL are not referred to in this document.

from east to west. Near the east end of the linear accelerator, the parcel of land expands out to 910 meters providing space for experimental facilities and buildings. A site map showing the layout of expanded land parcel with the experimental facilities and buildings is provided in Appendix 1.

SLAC employs approximately 1200 full- and part-time personnel. An additional 250 to 500 visiting scientists from other institutions may be involved in carrying out experiments at SLAC at any given time. SLAC administration is comprised of six divisions: Technical; Business Services; ES&H; Research; SSRL; and PEP-II. No other major DOE contractors are located permanently at SLAC. Temporary users of SLAC facilities (who generally have supplementary outside funding) are under the jurisdiction of SLAC with respect to the control of hazardous material.

No products are manufactured at SLAC for commercial markets. Equipment, varying from minute electronics parts to large detector assemblies, is constructed solely for use in non-profit high energy physics research programs. The energy demand for operation of the 2-mile linear accelerator and experimental equipment is great. All electrical energy is supplied to SLAC from the local utility and the utility grid.

2.1.2 Site Research Activities

Stanford's 50-year contract with DOE began in 1962. Experimental research started in 1966 with the completion of the two-mile linear accelerator, which can produce beams of electrons and positrons with energies of up to 50 billion electron volts. The 2-mile linear accelerator was originally designed for use in stationary target experiments. Since 1966, three other major research facilities have been built at SLAC: the Stanford Positron-Electron Asymmetrical Ring (SPEAR) storage ring (1972), the Positron-Electron Project (PEP) storage ring for colliding beam experiments (1980), and the Stanford Linear Collider (SLC) for single pass colliding beams interacting at a fixed location (1989). SSRL conducts research in such fields as materials science, protein crystallography, catalytic chemistry, surface science, and diagnostic radiology.

In association with Lawrence Berkeley National Laboratory (LBNL) and Lawrence Livermore National Laboratory (LLNL), SLAC is engaged in a new high energy physics research project, the Asymmetric B Factory. This project investigates the phenomenon of charge-parity (CP) violation or the predominance of matter over anti-matter in the universe and will study the relationship of elementary subatomic particles (B mesons) for refining the Standard Model of particle physics. To produce and detect subatomic phenomena resulting from interaction of electron-positron collisions, SLAC's existing experimental facilities are being modified. In very simple terms, this project requires: (1) modifications in the operation of the existing 2-mile linear accelerator and (2) design of two new rings and associated detection equipment. The new research facility is called PEP-II and utilizes the original PEP tunnel.

Construction activities for the PEP-II facility have been in operation since 1994. PEP-II demonstrates an example of waste reduction and pollution prevention in high energy physics research by efficiently making use of SLAC's existing facilities and resources. For example, the PEP-II project will be reusing the original PEP underground tunnels and many of its beamline magnets to operate the new PEP-II storage rings.

2.2 Description of Operations

SLAC performs various operations which generate three major categories of wastes: nonhazardous, hazardous and low level radioactive waste. SLAC does not generate high level or transuranic radioactive wastes. SLAC uses various toxic chemicals. Two toxic chemicals are used in significant quantities, sulfuric acid and 1,1,1-trichloroethane (trichloroethane).

2.2.1 Nonhazardous Waste Operations

2.2.1.1 Nonhazardous Waste Generation and Recycling

SLAC is like many other educational or commercial facilities in the types of nonhazardous waste it generates. The most common waste include: food wastes and beverage containers, various office papers, newspaper, magazines and directories, paper towels, textiles, cardboard, wood, garden waste, and various construction and janitorial wastes. SLAC has been implementing a recycling program through Stanford University since the late 1980's to divert potential wastes from disposal to municipal landfill. Recycled or diverted materials include: beverage containers, various office papers (white ledger, computer blue-line, newspaper, and mixed paper categories), directories and books, cardboard, wood, garden waste, and some reusable construction materials. Mixed paper includes colored paper and junk mail.

Like some industrial facilities, SLAC generates significant quantities of scrap metals, mostly stainless steel, copper, aluminum, and lead. SLAC's various machine shops, for example, collect scrap metals and send them to the SLAC Salvage Group. At Salvage, the materials are sold to metal recycling vendors. Before sending scrap metals to the Salvage Group, all metals are surveyed by the SLAC Operational Health Physics Department (OHP) in accordance with the SLAC Radioactive Materials Management Program (References 3 and 4).

Other nonhazardous or special wastes are also recycled. Some examples are:

- In SLAC's Motor Pool, used vehicle tires from automotive and moving equipment are picked up by a subcontractor and sent to an off-site energy recovery facility.

- Site-wide, used laser printer toner cartridges are picked up and recycled through SLAC's office supply vendor.

- In the SLAC Shipping and Receiving Department (S&R), Styrofoam beads are collected from incoming packages. The beads are reused by S&R for outgoing packages.

SLAC also has an active hazardous waste management program to prevent certain common hazardous wastes from being illegally disposed to municipal landfill (discussed in General Description of Hazardous Waste Operations (section 2.2.2.1).

2.2.1.2 Disposal and Recycling Operations

In general, the existing nonhazardous recycling program is administrated by the SLAC Facilities Department (FAC). FAC uses a subcontractor to implement the program. The subcontractor supplies SLAC with collection containers that are typically stationed inside and outside various buildings. The subcontractor collects the contents of the various containers as they accumulate with the recyclable materials. SLAC employees are aware of the recycling program and actively use the containers to recycle:

- Various papers in the form of white ledger paper, mixed paper, newspaper

- Beverage containers in the form of polyethylene terephthalate (PET, designated Number 1 Plastic), high density polyethylene (HDPE, designated Number 2 Plastic), glass and aluminum

- Magazines and directories

SLAC employees deposit recyclables to these containers. The contents of the collection containers are trucked by the subcontractor to a centralized facility on the University campus where materials are further sorted and packaged for recycling.

Cardboard is typically deposited by employees next to the trash dumpsters. FAC picks the cardboard and deposits it into a centralized dumpster that is emptied by the subcontractor on a monthly basis. Wood waste is also collected by FAC in a centralized dumpster. Garden waste is accumulated by the gardening subcontractors and also collected in a centralized dumpster.

Traditionally blue-line computer paper was a recyclable that was picked up by the Salvage Group, who in turn received value for its recovery by the recycler. This computer paper is being phased out and replaced by white ledger paper.

Nonhazardous waste that is earmarked for landfill disposal is typically collected in 7-cubic yard dumpsters located around the site. The contents are picked up by SLAC's subcontractor, typically twice per week. Collection containers for office recycle materials are placed in various locations inside or outside the most active buildings around the site and are typically of 20 or 55 gallon Kraft barrels. The contents are picked up by a subcontractor on a one- or two-week basis and sometimes on a will-call basis. Centralized dumpsters for collecting cardboard, wood, and garden wastes are typically 20 to 30 cubic yard capacity, and the contents are picked up once per month.

A site map is provided in Appendix 2 to show the locations of the various outdoor dumpsters which are used to collect municipal waste, the main buildings which have office paper (and beverage container) recycle collection containers, and the centralized dumpsters which are used to collect cardboard, wood and garden wastes. Also, proposed vendor pickup locations for new recycle containers are shown. The containers and locations are planned for a pilot and new recycling program discussed in Section 4 (Waste Stream Description and Evaluation).

2.2.2 Hazardous Waste Operations

2.2.2.1 General Description of Hazardous Waste Operations

Hazardous waste can be categorized as: (a) operational hazardous waste, (b) Toxic Substances Control Act (TSCA) waste, and (c) remediation waste. Operational hazardous wastes are simply defined as the result of SLAC operating and maintaining operations that are directly applicable to the site’s mission. TSCA wastes result from removal of old electrical equipment (polychlorinated biphenyls [PCB]-containing equipment) and construction practices (asbestos containing materials). These wastes result from the phasing out these materials from use in SLAC operations. Remedial wastes are the result of past practices or accidental spills. TSCA and remediation wastes are expected to reduce over time by elimination of the sources PCB and asbestos wastes and by organized site assessment and site cleanup activities. The TSCA and remedial waste streams are categorized separately since they are being eliminated in long-term planning activities covered under separate budgets and resources. The Plan focuses on the reduction of operational hazardous wastes.

Generation of these three categories of hazardous waste are shown in the Table 1 below for the period from 1990 to 1996. The values in this table are shown graphically in Figure 2. From Table 1, the following can be noted:

- Operational hazardous waste made up 10 to 59 percent of the total hazardous waste generated. The balance of the hazardous waste was from TSCA and remediation wastes.

- SLAC has achieved 42 percent reduction in operational hazardous waste in 1996 relative to the 1993 generation of operational hazardous waste.

- SLAC achieved 75 percent reduction in operational hazardous waste relative to 1990 generation in operational hazardous waste.

The Plan will further discuss generation and reduction of operational hazardous waste. Because of their nature, TSCA and remediation wastes are not included in waste reduction activities.

2.2.2.2 Routine and Nonroutine Hazardous Waste Operations

Since SLAC is an experimental facility, no major product is generated for export from SLAC other than pure research of high energy particle physics. As a result, hazardous waste generation results from the use of chemicals, not their production. Some hazardous waste generation is partially dependent on the operation of the beam and the type of research occurring. Certain activities occur repeatedly or by a defined frequency to operate and maintain equipment associated with the 2-mile linear accelerator and associated detection equipment, for example, changing oil in vacuum pumps, flushing cooling systems, and cleaning parts used on a frequent basis. Other routine activities may include painting and cleaning of office and laboratory building. These operations routinely generate hazardous wastes since the are generated repeatedly in a definable period.

Some hazardous waste generation is the result of construction and maintenance activities that occur on a nonperiodic or one-time basis. Examples include adding a new building, replacing a boiler or cooling tower, and performing a special one-time parts cleaning for another laboratory. These operations result in nonroutine hazardous wastes since they are nonperiodic or one-time in nature.

As a research facility, it is not always easy to differentiate between routine and nonroutine operations. Since 1990, they were commonly lumped together and called operational hazardous waste. In the SB 14 Plan, SLAC tracked routine and nonroutine hazardous wastes according to California guidelines. This was fairly straight forward. However, tracking routine and nonroutine waste to meet DOE waste reduction goals and contract performance objectives may require more effort in differentiating between the two to prevent failures in waste reduction performance. Another example of a nonroutine project or waste generation activity is briefly discussed here that will be use in discussion of Site Goals and Performance Measures (Section 3). In this example, SLAC does not want the generation of this waste to be considered a failure in achieving waste reduction goals or DOE-imposed performance objectives and measures.

SLAC is upgrading the electrical equipment in its Master Substation which consists of high power, high voltage electrical transformers, capacitors, and other oil-filled equipment. This is a one-time operation that will result in a large quantity of waste oil that may occur over one or more years. The one-time activity will also result in oily solid waste in the form of absorbents, rags, and non-reusable containers. SLAC will try to reduce generation of oil and oily solid wastes from the project; however, these oil and oily solid wastes are considered nonroutine. For existing oil-filled electrical equipment, an oil change is a rare, non-predictable, and nonroutine event since the oil may last the life of the equipment. Where practical, SLAC may reduce the generation of nonroutine oil waste by replacing oil-filled electrical equipment with alternative equipment which does not use oil, perhaps air-cooled equipment. Such equipment will eliminate nonroutine oil waste and may be considered in SLAC’s waste minimization performance.

2.2.2.3 Operational Hazardous Wastes by Types of Materials Used

Operational hazardous wastes generated at SLAC can be broken down into the following categories of materials and uses:

- Acids, alkalis, salt and cyanide solutions, and spent filters from metal finishing operations
- Acid, alkali, and spent deionization resins from cleaning low-conductivity water cooling systems
- Heavy metal filter cakes from chemical treatment of rinse waters in metal finishing and heat exchanger cleaning operations
- Empty containers from any operations that use chemicals
- Petroleum oils from machining operations and use of mechanical equipment such as pumps, compressors, electrical generators, electrical power systems (transformers, capacitors, etc.), klystrons, automotive vehicles and hydraulically-driven equipment
- Petroleum oil solids from cleaning and maintenance of the equipment using petroleum oils
- Solvent liquids used in vapor degreasing equipment in metal finishing operations and various equipment cleaning operations
- Solvent solids from wipe cleaning and maintenance of equipment and various surfaces
- Laboratory chemicals used for chemical testing, small-scale experiments, and photography
- Office and site maintenance chemicals such as cleaners, sealers, paints, adhesives, etc.
- Out-of-date and off-specification chemicals such as dielectric oils, etc.

The SLAC Waste Management Department (WM) implemented a system for reviewing and collecting hazardous wastes from SLAC generators, and for packaging, tracking, documenting and shipping hazardous wastes to permitted treatment, storage and disposal facilities (TSD). Some potential hazardous wastes, when properly handled, can be excluded from the hazardous classification. Examples are automotive batteries and empty chemical containers. Spent automotive batteries are sent directly to a recycler by Motor Pool. In 1996, WM implemented a procedure for recycling empty chemical containers as scrap metal rather than sending off-site as hazardous waste.

2.2.2.4 Operational Hazardous Waste by Types of Operations

An alternative breakdown is provided below to identify operations which result in the generation of hazardous waste by the type of operation and location. To assist in identifying locations of operations, refer to the site map in Appendix 1 which shows the associated buildings and structures by number. A breakdown of hazardous waste operations and waste types is as follows:

- Machining and fabricating various (mostly metal) parts and components for the 2-mile linear accelerator, SPEAR, SLC and PEP-II mainly by Mechanical Fabrication Department (MFD) at Buildings 25 and 26, by SSRL at Buildings 120 and 137, by the Klystron/Microwave Test Laboratory (KLY) at Building 44, and by some smaller operations of other departments throughout facility - oils, solvents, deionized water resins, filters, oil and solvent solids as rags and absorbents

- Cleaning and plating metal parts or components by Metal Finishing Operations under MFD at Building 25, and chemically treating associated rinse water in the rinse water treatment facility (RWTF) at Building 38 (also under MFD) - acids, alkalis, cyanides, spent filters, heavy metal filter cake

- Maintaining heat exchange systems, cooling towers, deionized water or systems and operating an associated batch wastewater treatment facility at Building 460 by the Plant Engineering Department (PE) to support the 2-mile linear accelerator and Klystron Gallery operations at Buildings 1 and 2 - acids, alkalis, and heavy metal filter cake

- Fabricating, maintaining, and testing klystrons and associated microwave generation equipment by KLY at Building 44 - oils, solvents, oil and solvent solids as rags and absorbents

- Fabricating, maintaining, and testing specialized equipment (e.g., electron guns), performing small-scale experiments, and testing of materials with highly specialized analytical techniques by the Physical Electronics Laboratory Department (PEL) and various experimental groups in the Central

Laboratory at Building 40 and other locations - various laboratory chemicals and solvents

- Fabricating, maintaining, and testing equipment used to conduct experiments with synchrotron radiation by SSRL at Buildings 120 and 137 - solvents, oils, laboratory chemicals, oil and solvent solids

- Fabricating, maintaining, and testing of subatomic particle beam lines and detection equipment by the Experimental Facilities Department (EFD) at Buildings 61, 62 and various building in the vicinity - solvents, oils, laboratory chemicals, oil and solvent solids

- Maintaining automotive vehicles by the FAC Motor Pool at Building 81 - oils, solvents, oil filters, oil and solvent solids, and other automotive fluids

- Maintaining heavy-duty trucks and hoisting equipment by PE at Building 18 - oils, solvents, oil filters, oil and solvent solids, and other automotive fluids

- Maintaining offices, grounds, buildings, boilers, and heating ventilation, and air conditioning equipment by FAC - oils, solvents, other chemicals, asbestos

- Replacing and maintaining electrical equipment by PE and the Power Conversion Department (PCD) in the 2-mile linear accelerator (Buildings 1 and 2), the Master Substation, and various substations around the site - oils , oils containing polychlorinated biphenyls (PCB), solvents, and oil and solvent solids

- Remediating soils by the Environmental Protection and Restoration Department (EPR) at various locations around the site - soils and well drillings containing various contaminants

2.2.2.5 Description of Major Hazardous Waste Operations

The following operations are discussed in further detail since they produce operational hazardous wastes that are 5 percent or more of the total operational hazardous waste in any one-year time period.

<u>Metal Finishing Operations</u>
A general flow diagram of the hazardous materials and hazardous waste streams from Metal Finishing is provided in Figure 3. Metal Finishing performs a wide variety of activities to meet demanding and sometimes unique metal finishing specifications needed to fabricate equipment for high energy physics experiments. Operations include: vapor degreasing using trichloroethane; aqueous cleaning and etching; and plating of copper, carbon steel, stainless steel, and aluminum parts.

The various baths in Metal Finishing provide the capability to clean parts and plate them with metals such as nickel, copper, tin, rhodium, indium, silver and gold. Cyanide copper, gold, and silver baths are typically used in Metal Finishing and are considered essential to SLAC's plating needs. Metal Finishing used to perform plating of printed circuit boards but phased out these operations after 1991 thus helping in SLAC's waste reduction effort. Cleaning and plating baths are maintained by continuous filtration, which helps preserve bath life.

Nonhazardous rinse water is generated by using tap or deionized water to rinse residual plating bath solutions from the parts being plated. After rinsing parts, the rinse water typically contains below-regulatory levels of hazardous metals, mostly copper and nickel. The RTWF is a pretreatment system that allows SLAC to meet sanitary sewer discharge requirements of the Clean Water Act for metal finishing operations. The rinse water is treated in the RWTF using neutralization, flocculation, and sedimentation processes to remove metals and adjust the pH of the water, and is discharged to the publicly-owned treatment works (POTW), the South Bayside System Authority (SBSA). The sedimentation process gravity separates the heavy metal sludge, which is subsequently sent through a filter press and a dryer to produce a filter cake.

Aside from alkaline, acid and cyanide wastes, Metal Finishing generates spent halogenated solvents from vapor degreasing operations and empty containers that last contained (1) degreaser solvents, (2) plating bath solutions, (3) make-up chemicals, and (4) fuels to operate portable steam cleaners.

Spent aqueous cleaning and plating baths, the filter cake, halogenated solvents, empty containers and filters are sent off-site to a permitted TSD or recycling facility. Because of the phaseout of ozone-depleting solvents such as trichloroethane under the federal Clean Air Act, Metal Finishing developed alternative methods to clean parts, and plans to significantly reduce the use of trichloroethane in the near future.

<u>Low-Conductivity Water System Cleaning Operations</u>

Low-conductivity water (LCW) is used in cooling applications at SLAC to reduce fouling in the cooling lines and to allow the 2-mile linear accelerator and other associated equipment to operate at constant temperature, an important requirement for successful high energy physics experiments. Many of the cooling lines are constructed of copper. Some systems are constructed of aluminum. The amount of scaling or oxidation on the lines is dependent upon operating conditions of the accelerator. When the heat transfer is significantly lowered by scaling or oxidation of the cooling line walls or wetted areas, the lines are cleaned by flushing and rinsing operations. Sometimes, cleaning activities may need to be performed under emergency conditions in order maintain operational continuity of high energy physics equipment during critical experimental tasks.

In a typical LCW cooling system cleaning operation, the lines to be cleaned are isolated from the rest of the system and filled with the flush mixture. Flushing agents are a detergent-phosphoric acid mixture for copper lines and alkaline solution for aluminum lines. The mixture is circulated for a period of time, then drained from the lines and collected in a container or tanker labeled to designate it as hazardous waste. The detergent-phosphoric acid mixture collects copper from the cleaning process and produces a low pH, high copper concentration waste stream that can be hazardous. Flushing of aluminum lines can result in a high pH solution containing aluminum. The pH and aluminum levels of the resulting wastewater, however, are usually tested and found to be nonhazardous and can be directly discharged to the POTW.

After the copper or aluminum lines are flushed, they are rinsed with deionized water to remove residuals that remained in the lines from the flushing operation. The rinse waters are typically collected in tanks separately from the flushing agent and analyzed to test that they are non-hazardous. The rinse water is subsequently treated in the batch waste water treatment system at Building 460 to meet pretreatment standards required for the water to be discharged to the POTW.

Pretreatment of the rinse waters involves pH adjustments to:

- increase the rinse water pH (initially between 2 and 6) to the discharge limit allowed by the POTW (pH between 6 and 12.5)

- remove copper from the rinse water (initially with copper less than 25 mg/l) to the discharge limit allowed by the POTW (less than 0.79 pounds of copper per day).

Small quantities of sludge may result from the pretreatment of these rinse waters. These sludges are handled as hazardous waste and sent to a permitted TSD.

Where possible, flushing solutions are reused to perform multiple cleanings of different lines of the LCW cooling system to reduce hazardous waste volume and to obtain maximum use of the flushing agents. Reuse of copper flushing agent to perform multiple (back-to-back) cleanings help reduce the generation of this waste stream. Aluminum lines have not required cleaning in the last few years since aluminum cooling systems have not been used as frequently as in the past and are not expected to have increased usage in the future.

<u>Operations Generating Waste Oil and Mixed Oil</u>
Unlike the aqueous waste streams from metal finishing and LCW cooling system cleaning operations, the oil and mixed oil waste stream comes from numerous sources. As mentioned earlier, oil wastes come from maintenance of electrical and

mechanical equipment, and machining and fabrication operations. Oil is an inherent component for successful operation of machinery and equipment. In some cases, SLAC has been able to reduce oil waste at the source. For example, some pump equipment operates on synthetic oils which have a longer operating life than conventional petroleum oils thus reducing the frequency of oil change. The use of a synthetic oil, however, requires equipment manufacturer guidance and endorsement of such oils to maintain equipment warranties and operating performance. PE and Cryogenic Operations (CYO) have also reduced waste oil by upgrading equipment where possible. Waste oil is typically sent off-site to a permitted oil recycler.

<u>Operations Generating Unspecified Oil-Containing Waste</u>
Like waste oil, the generation of unspecified oil-containing waste (as solids) comes from numerous sources and is typically generated in the form of rags used to clean equipment, absorbents used to clean shop areas, and oily metal scrap from pipe threading operations. Because of age, some equipment inherently drips oil into contained areas. A source reduction measure is to replace such equipment when the equipment has reached the end of its useful life and when funding for new equipment is available. As mentioned above for waste oil, unspecified oil-containing waste has also been reduced by CYO by upgrading equipment and by the addition of containment measures. Oil-containing wastes will require careful investigation since numerous sources generate this waste. Careful evaluation will also be required because waste reduction competes with efforts to keep work areas clean.

2.2.3 Low Level Radioactive and Mixed Wastes

Most low level radioactive and mixed wastes are characteristically nonroutine and are usually generated as a part of the 2-mile linear accelerator maintenance and upgrades. These materials are part of the accelerator and beamline structures, components and equipment. Normally such materials remain in the accelerator housing and tunnels, which are classified as Radioactive Material Management Areas (RMMA). When portions of the structure, components or equipment must be removed for repair or reconstruction, they are surveyed for radioactivity. Items found to be nonradioactive are released for unrestricted use and recycled. Radioactive materials are reused where possible to minimize generation of waste. When not reusable, these materials become low level radioactive or mixed wastes.

A low level radioactive waste that is generated periodically is the spent resin beds used for deionizing low-conductivity water in various closed-loop cooling systems. Such waste is generated on a one- to three-year basis depending on the system.

2.2.4 Toxic Chemicals

SLAC uses numerous toxic chemicals listed under the federal Superfund Amendments and Reauthorization Act (SARA). Under DOE order, SLAC is required to prepare U.S. Environmental Protection Agency’s (EPA) Toxic Chemical Release Inventory Report on those toxic chemicals used at levels greater than 10,000 pounds per year and must report releases and off-site transfers of these chemical on an annual basis if the use of the chemical exceeds 10,000 pounds. In 1994, SLAC identified two listed toxic chemicals that are used in quantities exceeding 10,000 pounds per year, sulfuric acid and trichloroethane.

Sulfuric acid is mainly used for chemically treating cooling tower water. The primary use of sulfuric acid is to treat water in SLAC's cooling towers, which are used to meet the cooling requirements of the two-mile linear accelerator and other supporting equipment. Although hazardous, it is effective in this operation since it is more stable than nitric or hydrochloric acids (less fumes), has good ionic strength requiring less volume than the other acids, and results in fairly benevolent salts in the form of sulfates. Since sulfuric acid chemically reacts with the cooling tower water during the treatment process, sulfuric acid is not released to the environment. To reduce sulfuric acid usage, SLAC controls acid feed by using an automatic feed system based on pH control. As a result, sulfuric acid usage is minimized. Sulfuric acid was delisted and exempt from this reporting requirement by EPA as of 1995.

Trichloroethane is used in vapor degreasing systems. Trichloroethane is primarily used in (1) vapor degreasing systems mostly for precision cleaning applications in Metal Finishing operations, (2) cleaning vacuum system cold traps, and (3) other activities such as wipe cleaning electrical equipment. Vapor degreasing with trichloroethane is considered essential to SLAC's cleaning requirements for the two-mile linear accelerator and associated equipment. A substantial amount of equipment at SLAC operates at ultrahigh vacuum conditions, which require an extremely high degree of cleanliness. The measures SLAC has taken to replace trichloroethane is provided in Section 4 (Waste Stream Description and Evaluation).

2.2.5 Pollution Prevention

SLAC’s pollution prevention awareness program involves those measures that ensure facility compliance and employee awareness associated with a process or activity that impacts on the environment. Pollution prevention also includes training to increase employee awareness of those activities which generate wastes or which significantly impact environmental resources - air, water, and land.

SLAC’s waste minimization and pollution prevention activities are also supported and integrated with programs or activities to protect the environment. These programs are essential to compliance with federal and state regulations but also are important to planning and implementing waste minimization and pollution prevention as it relates to air, water and land, as well. Examples of pollution prevention that can provide benefit to the site include preventing spills or reducing use of hazardous materials. Pollution prevention may also include reducing water usage. In SLAC's Metal Finishing operations, for example, reducing rinse water usage also help reduce the use and costs of water treatment chemicals.

Some of the waste minimization and pollution prevention elements of the various programs are highlighted as follows:

- Nonhazardous Waste Recycling - providing employee awareness and voluntary recycling of nonhazardous materials (e.g., cardboard, various types of papers, redeemable beverage containers)

- Affirmative Procurement - purchasing of products which are made from or contain recycled materials (e.g., various papers, office products and printer cartridges)

- Pollution Prevention and Hazardous Materials/Waste Management Training - promoting employee and line management awareness and understanding of the management of hazardous materials and wastes

- Emergency Planning and Community Right-to-Know - identifying and inventorying toxic chemicals present on-site and reducing their use to comply with Toxic Chemical Release Inventory reporting

- Spill Prevention and Toxic Substances Control - preventing accidental or uncontrolled releases of hazardous or toxic materials and releases from oil-filled and polychlorinated biphenyl-containing equipment

- Ambient Air Quality Management - maintaining and inspecting air emissions control equipment, replacing ozone-depleting chemicals in fire extinguisher, air conditioning, and surface cleaning solvents with alternative materials or technologies; and tracking solvent usage

- Surface Water and Groundwater Protection - preventing pollution to surface water, groundwater, and storm water, and from spills of hazardous materials

- Hazardous Waste Management and Tracking - ensuring proper collection, handling, transferring, recordkeeping and tracking of hazardous wastes sent off-site to permitted recycling TSD facilities

- Radioactive Materials Management - performing thorough reviews to assure that equipment and systems are designed with reduced generation of radiation and providing measures to minimize the generation and disposal of low level radioactive and mixed wastes.

SLAC's activities to eliminate oil-filled electrical equipment containing PCB and to remediate contaminated soils, also contribute to SLAC’s pollution prevention program by eliminating the short- and long-term effects of soil and water contamination.

Pollution Prevention and Hazardous Materials/Waste Management Training

SLAC expanded its $2^{1/2}$-hour training class, Introduction to Hazardous Waste and Materials Management, to a 4-hour class to address pollution prevention as it relates to air, water and solid waste. The training was developed for employees who handle hazardous wastes and hazardous materials as part of their job. To date, over 500 employees have taken the $2^{1/2}$-hour class. Advance training is provided to SLAC’s Hazardous Waste and Material Coordinators. Additional training measures include but are not limited to the following:

- Publishing a monthly review to update staff and managers on new or modified environmental regulations
- Sending key staff to environmental training that relate to their work activities; examples include: alternatives to ozone-depleting solvents, pollution prevention technology workshops, and others
- Publishing ES&H Updates and Bulletins for site-wide distribution to inform staff of important environmental concerns that may affect them
- Preparing ES&H Manual Chapters to guide staff on air and water quality, management of oil-filled equipment, hazardous waste, spills, and secondary containment, as well as waste minimization and pollution prevention
- Preparing site-wide newsletter articles and focused presentations on pollution prevention and waste minimization

Emergency Planning and Community Right-to-Know

SLAC’s Safety, Health and Assurance Department (SHA) prepared a toxic chemical inventory to comply with emergency planning under the Superfund Amendment and Reauthorization Act (SARA). This inventory identifies the locations and quantities of toxic chemicals present on the site. SLAC’s EPR Department prepares EPA’s Toxic Chemical Release Inventory (TRI) report. This reports the major chemicals that are used on the site in quantities greater than 10,000 pounds. Up until 1995, sulfuric acid and 1,1,1-trichloroethane (trichloroethane) met the 10,000 pound criteria. In 1995, sulfuric acid was delisted from TRI reporting and SLAC has reduced its trichloroethane usage below 10,000 pounds. Reductions in SLAC’s use of trichloroethane are further discussed in Section 5 (Potential Source Reduction, Reuse and Recycling Measures for Major Waste Streams).

From these two activities and ongoing communication between the SLAC ES&H and Business Services Divisions, measures are being taken to identify, monitor and review toxic chemicals purchased by chemical users. This information will help identify chemical users and help them consider less hazardous alternatives.

Spill Prevention and Toxic Substances Control

SLAC has revised its Spill Prevention Control and Countermeasure Plan and has developed ES&H Manual Chapters (Drafts) on Spills, Oil-Filled Equipment and Secondary Containment to provide measures and guidance to minimize the impact of spills from hazardous materials storage.

In 1989, SLAC started removing or retrofilling electrical transformers containing or contaminated with PCBs. When transformers were removed, they were transferred to off-site permitted recycling or TSD facilities. SLAC continues to make significant progress in reducing its inventory of PCB-containing equipment. Electrical transformers containing oils with PCBs have been retrofilled so that most are non-PCB. One retrofilled transformer is in storage and will remain as PCB-contaminated until it is put in service. In service, it can be tested to determine if it is non-PCB.

Ambient Air Quality Management

Activities which have been performed or continue to be performed to prevent or reduce air pollution at SLAC are:

- Replaced older fire tube boilers used for site heating with low nitric oxide emission combustion systems to meet Bay Area Air Quality Management District regulations

- Developed alternatives to replace ozone-depleting solvents used in SLAC vapor degreasing operations and eliminated 3 of 4 vapor degreasing operations

- Eliminated extraneous cold cleaners around the site

- Providing regulatory guidance and information on alternatives to ozone-depleting solvents to various users in equipment cleaning operations, cooling systems, and fire protection equipment using ozone-depleting chemicals

- Notifying line departments of proposed and promulgated regulations under California's Bay Area Air Quality Management District and supports line departments by outlining regulatory requirements and preparing air permits

- Performing semi-annual inspections of air pollution abatement equipment

- Tracking solvent usage and solvent purchases

- Providing employee training in regard to spill prevention and containment of chemicals such as volatile organics.

Surface, Ground Water, and Storm Water Protection

Existing and ongoing activities used at SLAC to prevent or reduce surface, storm and ground water pollution are:

- Prepared a site-wide ES&H Update to inform SLAC staff that discharge wastewater to the sanitary sewer of POTW pretreatment standards
- Labeled storm water sewers and sink drains to remind staff not to use them for disposal of chemicals
- Replumbing various sumps from storm drain to sanitary sewer
- Developed an oil-filled equipment inventory and inspection program
- Monitoring storm water to identify potential pollutants
- Developed a Storm Water Pollution Prevention Plan and developed best management practices for source control, good housekeeping, and storm water protection
- Developed site-wide ES&H Bulletins and procurement contract requirements to address subcontract requirements for performing storm water protection measures in their work
- Reduced cooling tower blowdown volume to the sanitary sewer

Waste Management and Tracking

Waste minimization and pollution prevention emphasize reduction of hazardous waste sources and on-site reuse or recycling hazardous materials. However, the efforts of WM, which typically involve using permitted off-site recycling and treatment services, have significantly contributed to the reduction of hazardous waste disposal. WM provides a monthly report on waste reduction measures it has implemented.

The efforts by the WM Computer Systems Analyst and WM have significantly increased SLAC's ability to track hazardous waste streams from source to grave. With few exceptions, most of the data provided in this plan is from the recordkeeping efforts of WM and computerization of hazardous waste databases by the WM Computer Systems Analyst. Efforts will continue to increase the utilization and tracking capability of this computer system to help focus on waste reduction measures for specific hazardous waste streams and for specific waste generators. SLAC’s hazardous waste tracking system will continue to be refined to make it more user friendly in helping generate reports and analyzing and reviewing the types of wastes generated and the points of generation. WM and EPR have identified codes for the hazardous waste streams to help better understand trends in waste generation and to better track SLAC's hazardous waste generation activities.

3. Site Goals and Performance Measures

The Plan is developed with the following benefits in mind:

- Increase protection of public health and the environment
- Reduce waste management and compliance costs
- Reduce resource usage
- Maintain or improve product/service yields where applicable
- Reduce or eliminate inventories and releases of hazardous substances reportable under the Emergency Planning and Community Right-to-Know Act
- Reduce or eliminate liabilities under environmental laws

Where technically and economically feasible, SLAC will strive to improve the probability of achieving the above benefits. SLAC's approach to meeting these objectives is to use low-capital measures in the planning and implementation of waste minimization and pollution prevention opportunities. By using low-capital measures, SLAC increases opportunity to implement waste reductions that will provide a return (in less than three years) by reducing waste management costs. Where appropriate, SLAC will make requests to DOE-OAK for funding of waste reduction projects with potential return-on-investment (ROI).

Under the May 3, 1996 DOE Secretary Goals Memorandum, sites are to set waste reduction goals for routine wastes to be achieved by December 31, 1999 using 1993 as a baseline year. The goals are:

- 33 percent reduction in the generation of nonhazardous or municipal landfill waste
- 50 percent reduction in the generation of hazardous waste
- 50 percent reduction in the generation of low level radioactive waste
- 50 percent reduction in the generation of low level mixed waste
- 50 percent reduction in toxic chemical releases and off-site transfers

SLAC is currently using a combination of numerical- and project-based goals for performance objectives and measures of SLAC's performance in achieving the above goals. SLAC is working with DOE-OAK to finalize performance objectives and measures for 1998.

For calendar year 1996, SLAC met the performance objectives that were agreed upon between SLAC and DOE. The performance objectives were partially focused on achieving numerical goals, i.e., the goals in the DOE Plan (Reference 1) and the goals in the SB 14 Plan (Reference 2). In addition, to these performance measures, SLAC presented programmatic measures, e.g.,
training, presentations, newsletter articles, etc., to help increase employee awareness and to guide potential waste generators in addressing waste minimization and pollution prevention. DOE reviewed SLAC performance based on these objectives. SLAC was able to achieve over 80 percent of its objectives. SLAC wishes to use a similar approach to measuring performance for calendar year 1997 and subsequent years.

SLAC is working with DOE-OAK to better define how numerical goals can be used in measuring performance for nonhazardous and hazardous wastes. Relative to 1993 and 1994, SLAC's hazardous waste generation activity is expected to increase due to research activities associated with the Asymmetric B Factory Project and construction of the PEP-II facility. Hazardous waste quantities are not expected to return to 1990 levels due to SLAC's increased awareness and continued implementation of waste reduction measures. Increases in hazardous waste generation are expected from nonroutine activities such as replacement of electrical equipment in SLAC's Master Substation (discussed earlier in subsection 2.2.2.2 Routine and Nonroutine Hazardous Waste Operations) and from increased requests from other laboratories, LBNL and LLNL, for support in fabrication of special components that only SLAC can more easily produce than organizations outside the DOE complex. As a result, SLAC achievement of numerical waste reduction goals or performance objectives may not be attainable without compensation for nonroutine wastes or waste resulting from outside activities.

Numerical goals have not been set for low level radioactive and mixed wastes since these wastes are not manufactured or routinely produced but are generated only when SLAC removes beamline equipment or components from an RMMA. SLAC's approach to reducing low level radioactive waste involves (1) applying procedural measures and comprehensive surveying techniques and (2) applying measures to selected wastes on a case-by-case basis. Procedural measures may include preventing unnecessary materials (e.g., tools, excess metal stock, packaging, etc.) from entering or remaining in an RMMA and proper surveying, draining, flushing, and handling of potentially radioactive materials removed from these areas. Case-by-case waste reduction measures may include cutting up radioactive materials or disassembling components to separate radioactive items from nonradioactive ones.

SLAC and DOE-OAK are also involved in a ROI project to reduce disposal of surplus scrap metals as low level radioactive metals. These metals (aluminum, stainless steel and iron) are slightly activated and may be considered for release as nonradioactive materials. Such metals have radioactivity levels that are extremely low and may qualify from exemption from regulatory control. This project is in progress. The waste reduction approach is currently being developed between SLAC and DOE Oakland Operations Office (DOE-OAK). However, it is not appropriate and too early to define goals for this waste stream at this time.

4. Waste Stream Description and Evaluation

4.1 Nonhazardous Waste

The quantities of nonhazardous waste and the materials recycled or diverted from landfill from 1990 to 1996 are provided in Table 2. Figures 4 and 5 summarize SLAC's activity in recycling and diversion of nonhazardous waste from municipal landfill over this period. Material recycled or diverted is shown with and without scrap metal recycling to show the contribution of scrap metals. In 1990, SLAC achieved 10 percent diversion of nonhazardous waste without scrap metal and 25 percent diversion with scrap metal. In 1996, SLAC increased to 26 percent diversion without scrap metal and 49 percent diversion with scrap metal.

In general, from review of this data, SLAC sends an average of 650 tons of nonhazardous waste to landfill. The higher disposal quantity in 1991 was the result of facility-wide cleanup conducted prior to the DOE Tiger Team environmental, health and safety audit (October 1991). Of the 650 tons of nonhazardous waste typically generated, most of the waste consists of: bathroom paper towels, food wastes, and paper and cardboard products.

Nonhazardous waste diversion in 1995 was different from most other years because of a one-time event in which 1000 tons of concrete were diverted from landfill so that 65 and 73 percent diversion was achieved with and without scrap metal.

Consistent with the DOE Plan, SLAC has accomplished the following activities to support its waste minimization and pollution prevention program:

- Increased employee awareness and guidance to key managers in implementing recycling measures and buying recycled products by distributing SLAC's ES&H Manual chapter on Waste Minimization and Pollution Prevention

- Provided updates to SLAC's five Recycle Information displays to inform employees of recycling options and locations near their homes so they could also extend recycling good recycling practices in the workplace

- Established more consistent disposal and recycling data with SLAC's existing subcontractors

- Performed a brief waste evaluation survey in December 1996 with LLNL to further characterize and quantify SLAC's sanitary wastes and recyclable materials in SLAC's dumpsters

- Reviewed alternative measures (e.g., new subcontractors, alternate waste collection methods, alternate recycling vendors) to help increase waste recycling and to improve paybacks on recycled materials.

- Scrap lead is commonly reused for shielding. Some nonradioactive lead has been sent to outside vendors to remelt and reform into the shapes needed for different shielding applications.

- SLAC has increased its use of electric discharge machining (EDM), which has allowed SLAC to reuse more of its copper scrap since this machining technique is less destructive than conventional machining techniques. Some copper scrap has been reused as a source of copper in metal finishing operations.

The waste disposal subcontractor started weighing the nonhazardous waste in 1995. Previously, the weight of nonhazardous waste was based on volume and a density factor. Using weight as a measurement factor should help SLAC better track its waste generation.

SLAC performed a brief survey of its nonhazardous waste with help from the LLNL waste reduction coordinator. The survey was performed by visually checking nonhazardous waste dumpsters. It was estimated that SLAC could increase its recycling by approximately 3 to 7 percent over current recycling by capturing additional cardboard and mixed papers that were thrown in the dumpsters.

Historically, recycling materials did not provide a dollar return and the recycling program at SLAC operated mainly on a voluntary basis. Only high grade computer paper and scrap metals were of significant value to provide a monetary return from recycling. Consequently, those materials are handled by the SLAC Salvage Group. For other paper materials and redeemable containers, the monetary paybacks are relatively low, making cost-effective recycling difficult. Since 1993, SLAC has been encountering increased service costs from the subcontractor for recycling these materials. As a result, SLAC is further assessing its recycling activities and subcontractor services to determine if options are available to reduce these costs. DOE has provided funding to allow SLAC to develop a recycling program which allows SLAC a better ROI. A pilot recycling program is planned in June 1997 to test an alternative for collection of recyclable materials. A description of the program is provided in Appendix 3.

Activities in affirmative procurement are mainly from the purchase of recycled laser printer toner cartridges and various paper products. Re-refined oil has not yet been found to be cost competitive. Use of recycled white ledger paper is occurring at SLAC particularly in its largest generating area, the reproduction center of the Document Control Group. The approximate recycling rate is about 50 percent. Also, based on observation, SLAC employees have been implementing double-sided copying. This is an ideal paper reduction technique, but it is not one that is easily measurable for the purpose of goals and performance measures.

4.2. Hazardous Waste

The types and locations of operational hazardous waste were discussed earlier in subsection 2.2.2 (Hazardous Waste Operations). In summary, operational hazardous waste at SLAC is categorized by the following waste streams: (1) aqueous wastes (low or high pH, toxic metals, and cyanides) from metal finishing operations; (2) spent vapor degreaser solvents (halogenated hydrocarbons) from metal finishing operations; (3) aqueous wastes (low or high pH and toxic metals) from cleaning of LCW systems; (4) empty containers last containing hazardous materials; (5) spent oils, various solvents and research chemicals used to operate or maintain the cooling towers, the 2-mile linear accelerator, and to conduct various laboratory experiments; (6) spent cleaners, batteries, and other hazardous materials used in various facility construction/maintenance or office activities. Research chemicals are usually specialty chemicals and include photograph developer and fixing agents, scintillation agents, dyes, semiconductor materials, and many others. Facility maintenance and construction-related chemicals include cleaners, paints, adhesives, and other materials that cannot be disposed to a municipal landfill due to hazardous physical or chemical characteristics. Office chemicals are those that cannot be disposed to municipal landfill due to hazardous characteristics and their large-scale use in industrial or institutional organizations. These include typewriter white-out, dry cell batteries, organic and aqueous cleaners, and fluorescent bulbs.

The focus of SLAC's waste minimization activity has been in major routine waste streams. Reduction of routine hazardous waste has been addressed in the DOE and the SB 14 Plans. The DOE Plan addressed mostly site-wide measures to reduce routine hazardous waste. The SB 14 Plan focused on source reduction measures for major routinely-generated hazardous waste streams which are further discussed in the sections that follow.

SB 14 requires generators to evaluate their current processes for waste minimization opportunities and to create plans for workable waste reduction alternatives. Waste streams exceeding 5 percent of the sum of routinely generated waste are called major waste streams. Under SB 14, SLAC is required to examine and develop plans to reduce the major hazardous and extremely hazardous waste streams. Extremely hazardous waste are typically chemically reactive or highly toxic as defined in Title 22 California Code of Regulations (CCR) Section 66261.110.

Table 3 shows the hazardous waste streams by California Waste Codes (CWC) from 1993 to 1996. As discussed previously, the major waste streams constitute those that are greater than 5 percent of the total operational hazardous waste. Table 4 provides a key of CWCs by number and the associated description to assist in identifying waste streams in Table 3. Table 5 provides an extract of the major waste streams (those greater than or close to 5 percent in any of the reported years). Based on the SB 14 Plan, SLAC has one major extremely hazardous waste stream, liquids with cyanides (CWC 711).

4.2.1 Major Hazardous Waste Streams

Figures 6 through 13 show the quantities of the major hazardous waste streams in Table 5 by the key departments and operations to help identify the types of activities that generate these wastes. A similar breakdown of hazardous wastes by departments and operations was performed in preparation of the SB 14 Plan. Some waste reductions have already been implemented under the SB 14 Plan so that reductions in waste have already occurred. This plan will show a different distribution of waste by department and operation as a result of those reductions. A summary of those departments or groups contributing to the major waste streams is as follows:

CWC 122 Alkaline Solutions (pH > or = 12.5)
Table 5 shows 10 and 32 tons of this waste during 1993 and 1994. In the SB 14 Plan, Metal Finishing committed to reducing this waste stream by reusing it in the RWTF. The reduction of alkaline solutions has been in operation since 1995. In 1996, the contribution of Metal Finishing to this waste stream is significantly reduced to 448 kilograms (448 kg) or 0.4 tons as shown in Figure 6. As a result, this waste is no longer a major one; it was only 1 percent of the 1996 operational hazardous waste. Alkaline solutions from other operations (222 kg or 0.2 tons) are mostly associated with photographic solutions and miscellaneous caustic materials from various departments.

CWC 132 Aqueous Solutions with Metals (17 California Metals)
Table 5 shows what looks like the emergence of a new waste stream; however, it is a result of implementing waste reduction activities in the cleaning of LCW systems. Spent acid with metals (CWC 792) is normally generated from this operation. However, to reduce waste, the spent acid is used as much as feasible to perform back-to-back flush operations. The result is an aqueous solution (pH higher than 2 but less than 12.5) with metals. Note that no CWC 792 waste came from this operation in 1996 (see Figure 7). Maximum reuse of the acid is a good source reduction technique.

CWC 181 Inorganic Solid Waste Table 5 show that some inorganic solids were significantly reduced in 1995 and 1996. Figure 8 shows that part of the reduction is from cathode ray tubes (CRT) not being handled as hazardous waste; instead, CRTs are handled as salvageable materials by the Salvage Group under the Property Control Department (PRC).

Through Metal Finishing, MFD generated inorganic solids from plating bath filters and RWTF filter cake. Metal Finishing implemented a project through ROI funding from DOE-OAK to reduce plating bath filters in 1996. Further reduction should be achieved in 1997 when this project will be fully implemented.

RWTF filter cake has decreased thus far from Metal Finishing efforts to reduce its usage of ferric chloride, which is a necessary chemical used to remove metals in the RWTF; however, this chemical also is responsible for increasing filter cake volume. By reducing ferric chloride usage, the quantity of filter cake is reduced. In 1997, Metal Finishing is expecting to further reduce the quantity of filter cake by reducing the volume of rinse water treated in the RWTF. This is planned by implementing a project funded by DOE-OAK Waste Management in which deionized rinse water will be recycled, thus reducing the volume of water to be treated and the quantity filter cake that results from treatment chemicals.

CWC 212 Oxygenated Solvents (e.g., Acetone, Isopropyl Alcohol)
Table 5 shows that this hazardous waste is close to 5 percent of the total operational waste from year to year. With the phaseout of ozone-depleting solvents, it is expected that oxygenated solvents may be on the rise, for example, using acetone as an alternative to an ozone-depleting chlorinated solvent in wipe cleaning. Figure 9 shows the quantities of oxygenated solvents by departments. Isopropyl alcohol is used in Metal Finishing to clean and dry parts. Antifreeze used in automotive operations and cutting fluids used in metal machining operations are also listed as oxygenated solvents. Waste reduction techniques that come to mind for these operations are exercising good practices that will reduce the frequency of their usage. Feasible source reduction techniques include, for example, using only the quantity of cutting oil and isopropyl alcohol needed and minimizing antifreeze changeouts by maintaining automotive engine systems are reasonable source reduction.

CWC 221 Oil and Mixed Oil
Table 5 show that generation of this waste varies from year to year 19 tons in 1993, 8 tons in 1994, 13 tons in 1995, and 12 tons in 1996. Oil is commonly used in many types of mechanical equipment - automobiles, heavy-duty vehicles and hydraulic equipment, compressors, various pumps, klystrons, and electrical equipment, e.g., transformers, capacitors, etc. As a result, waste oil also comes from a number of departments depending on the oil use. PE generates oil waste from maintenance of mechanical and electrical equipment around the site. MFD generates oil waste from machining operations and KLY generates oil waste from removal of dielectric fluids in klystrons. EFD replaces oils used to operate compressors and vacuum pumps for cryogenic operations.

CWC 223 Unspecified Oil-Containing Waste
Table 5 show that generation of this waste varies from year to year. This waste stream is mostly oily solids (e.g., absorbents, rags, and other) from cleaning of

equipment of various departments as shown in Figure 11. These include the Power Conversion Department (PCD) from maintaining high power electrical equipment for the 2-mile linear accelerator and other operations; MFD from cleaning of machining and fabrication equipment; CYO from maintaining compressors and vacuum pumps; WM from collecting and consolidating wastes from numerous departments; and PE from maintaining electrical power systems. Assuming that oil cannot go away, a useful waste reduction technique is to remind employees to conserve, where practical, their use of rags and absorbents.

CWC 512 and 513 Empty Containers (= or > 30 Gallons and < 30 Gallons
Empty containers greater than 30 gallons are typically 55-gallon drums which last contained oils, chemical solids and solutions from various departments. Table 5 shows that SLAC has decreased its use and disposal of these containers since 1994. This is due in part to ordering and storing bulk quantities of chemicals used for cooling tower water treatment and reduced usage of chemicals in the RWTF. Smaller containers, 30 gallons or less have also decreased probably from (a) the efforts of various departments to conserve on chemical usage and (b) changes in operations and activities. Figure 12 is used to show the 1996 quantities of the two container categories.

CWC 791 and 792 Liquids with pH < or = 2 without and with Metals
Table 5 shows that liquids or acids without metals have decreased in 1996. This is due to efforts in Metal Finishing to reuse acids in the cleaning and etching operations. Figure 13 shows that Metal Finishing is the prime generator of acids with metals. Acids with metals are used for cleaning and etching are mostly generated by Metal Finishing Operations. As mentioned earlier, acids with metals would have also been generated by PE from cleaning of LCW systems; however, less hazardous Aqueous Solution with Metals (CWC 132) was generated instead by reusing the solution for back-to-back or multiple cleaning jobs.

4.2.2 Major Extremely Hazardous Waste Streams

SLAC generates one major extremely hazardous waste stream that must be addressed under the SB 14 Plan - liquids with cyanides that are in Metal Finishing Operations. Liquid cyanides are considered essential to the plating applications used by Metal Finishing.

Liquids with cyanides > or = 1000 mg/l (CWC 711)
Metal Finishing has provided semi-annual reports indicating that suitable replacements for copper cyanide baths have not been found for SLAC's technical needs. Alternatives will continue to be pursued.

4.3 Low Level Radioactive and Mixed Wastes

The quantities of low level radioactive and mixed wastes are the accumulations of waste generated over years of SLAC's operation. SLAC's current inventory of low level radioactive wastes are provided in Table 6. A significant portion of SLAC's low level radioactive waste is in the form of scrap metals. Depending on their condition and the radiological characteristics, some of the metals may be ideal candidates to return to the environment for reuse because radioactive levels are extremely low and may be exempt from regulatory control. This waste reduction approach is further discussed in Section 5.3 (Low Level Radioactive and Mixed Waste).

4.4 Toxic Chemicals

Table 7 shows SLAC's usage of trichloroethane from 1993 to 1996. As mentioned earlier trichloroethane is used in vapor degreasing operations and is essential for cleaning applications associated with ultrahigh vacuum. SLAC now only has one open-top system in the Metal Finishing Operation as opposed to three in the past. Reducing the number of degreasers has helped cut back trichloroethane usage. With the phaseout of ozone-depleting chemicals in 1996 under the Montreal Protocol, SLAC has also reduced its trichloroethane usage in other cleaning applications such as wipe cleaning.

5. Potential Source Reduction and Recycling and Reuse Measures for Major Waste Streams

A description of potential source reduction measures and other waste reduction measures are discussed below.

5.1 Nonhazardous Waste

Additional recycling might be achieved by addressing the paper towels and food wastes; however, the technical and economic considerations in reducing these wastes would require significant study. Acceptable measures for reduction of these wastes are questionable at SLAC. For example paper towels may be reduced by the use of electric hand dryers; however, many employees would strongly object because their work depends on being able to rub their hands dry on a clean material such as paper towels. Also, the expense of installing electric hand dryers in numerous, frequently-used bathrooms, over 40, would require an estimated cost of over $100,000. Food composting would require the efforts of a full-time person and an area to perform the composting. Currently, the feasibility of this option is questionable since the food waste would still have to be carried to a centralized area. Much attention would be required for this area by the full-time person. Consideration would also have to be given to managing potential health hazards from insects and animals feeding off this waste.

Food waste might also be reduced by the SLAC Cafeteria subcontractor by giving potential food waste to charity; however, it is common for cafeterias to reduce food waste by reuse in next day menus.

It appears that SLAC's best option at this time is to focus on recovering the cardboard and paper that is escaping recycling. SLAC is currently taking measures to try to capture these materials into its existing recycling program by improving on the collection of recyclable materials. A proposed project, that has been in part funded by DOE is provided in Appendix 3.

5.2 Hazardous Wastes

Periodic assessment of hazardous waste streams and hazardous waste generating operations is an important element in identifying technically and economically feasible opportunities to reduce wastes and prevent pollution. SLAC performed a number of reviews to determine major hazardous waste streams and potential reduction opportunities for those streams.

The following reviews were performed and are referenced as follows:

- 1994 Review - hazardous waste source reduction plan and report required under SB 14 to identify changes in waste generation activity between 1990 and 1994 and to develop waste reduction opportunities for the period from 1995 to 1998 (Reference 1)

- 1995 Review - hazardous waste generation activity and reduction opportunities for hazardous waste generated during the period January through October 1995 (Geomatrix, June 1996, Reference 7)

- 1996 Review - hazardous waste generation activity and reduction opportunities based on SLAC's 1996 hazardous waste tracking database

The 1994 Review of hazardous waste generation was prepared by SLAC to develop and recommend hazardous waste reduction measures and goals, which are required under SB 14 as milestones to be met by the close of 1998. The 1995 Review was a study to identify waste reduction opportunities based on the 1995 hazardous waste generation data. The 1996 Review was prepared by SLAC to determine how well it will be able to meet the hazardous waste reduction goal set by DOE.

The 1994 Review focused on the largest waste streams to develop preliminary opportunities that showed potential technical and economic feasibility. The 1994 Review was distributed to key departments or operational staff that generated significant portions of the major waste streams identified in 1994. Major waste streams that needed to be reduced are spent acids, alkaline solutions, waste oil/oily waste, oily solids, and other inorganic solid wastes. SLAC has been making progress in the reduction of alkaline solutions and other inorganic wastes through measures implemented in 1995.

From the 1995 Review, the major waste streams generated at SLAC over the review period were waste oil/oily waste, oily solids, solvents, rinse water treatment filter cake, and empty containers. A list of potentially feasible waste reduction opportunities for these waste streams was reviewed in the Geomatrix Report. The potential waste reduction opportunities are summarized as follows:

- Alkaline solution reuse

- Reducing transformer oil usage by longer life oils, alternative cooling media, or on-site oil-reprocessing

- Reuse of spent absorbents used in for machining oil cleanups

- Empty container crushing and recycling as scrap metal

- Reducing empty 5-gallon containers from kerosene refueling of steam cleaners
- Reducing plating bath cartridge filters
- Acid recovery and reuse

Some of the above hazardous waste reduction opportunities have been implemented during 1995, in particular reuse of alkaline cleaners. Alkaline cleaners were as high as 10,000 kg (in 1994). Reduction of this waste stream significantly contributed to the 20 percent reduction in operational hazardous waste in 1995 (relative to the 1993 baseline). Empty container recycling and reducing plating bath cartridge filters are currently being implemented. Included but not quantified here is the reduction of Inorganic Solid Waste (CWC 181) which resulted from reduced chemical usage in the Plating Shop.

Measures identified in this plan that the Metal Finishing will use to reduce the major hazardous and extremely hazardous wastes are presented below for each major waste streams based on review of the 1996 operational hazardous waste inventory presented in Table 5. As mentioned above, waste reduction goals have already been achieved for alkaline solutions (CWC 122) and liquids or acids without metals (CWC 791).

5.2.1 Aqueous Solutions with Metals (CWC 132)

As mentioned earlier this is an emerging waste stream that has resulted from LCW cleaning operations and is basically an offshoot of what would have been another waste stream, liquids or acids with metals (CWC 792). PE has conducted LCW system cleaning operations to significantly reduce potential waste by conducting back-to-back cleaning operations to maximize reuse of cleaning solutions.

Another source reduction technique that has been implemented by PE is the installation of a LCW deoxygenation system. This system is supposed to remove free oxygen from LCW systems to prevent oxidation and fouling of copper cooling lines thus reducing the frequency of cleaning LCW systems. If free oxygen is generated by radiation-energized water, then the deoxygenation system may only provide temporary removal of oxygen. If the deoxygenation system can remove free oxygen as fast as it is generated by the radiation energization process, then free oxygen levels may be kept sufficiently low to reduce the rate of copper oxidation, thus the frequency of cleaning. The effectiveness of one deoxygenation system is being evaluated over the long term.

A last alternative that is currently being pursued by SLAC to reduce this waste stream is a treatment option. SLAC is currently pursing PBR, to reduce the hazard level of this waste stream so that it can be discharged to the sanitary sewer. Small volumes of waste will still be generated in the form of inorganic solid (CWC 181) when this waste stream is treated in the batch wastewater treatment facility (Building 460). However, waste volume will be substantially reduced.

5.2.2 Inorganic Solid Waste (CWC 181)

A major contribution to inorganic solid waste (CWC 181) is from the generation of heavy metal filter cake in the RWTF. A significant portion of the heavy metal filter cake contains iron in the form of iron oxide or iron hydroxide. These iron compounds result from the use of ferric chloride, a coagulating or flocculating agent, for precipitation of heavy metals. Typically, the quantity of ferric chloride used is proportional to the amount of water to be treated in the RWTF. In order to reduce the volume of filter cake, Metal Finishing has reduced its rinse water usage and in turn the volume of water to be treated by the RWTF. Between 1991 and 1994, Metal Finishing reduced rinse water from 2.5 million gallons per year to 1 million gallons per year. Consequently, heavy metal filter cake quantities have been reduced by 60 to 80 percent relative to 1990 quantities.

Metal Finishing is also engaged in a project funded by DOE-OAK Waste Management by reusing deionized rinse waters. Currently, nonhazardous deionized rinse waters are sent to the RWTF for processing before discharge to the POTW. Metal Finishing is required by SBSA to pretreat this water before it is discharged to the sanitary sewer.

A potential system for reusing deionized water usage and treatment by the RWTF is shown schematically in Figure 14. The system shown will recycle a portion of the deionized water used in rinse tanks. The deionized water will be purified using reverse osmosis or mixed deionization beds. The advantage of reusing the deionized water is that it contains only minor (nonhazardous) contamination from rinsing operations. As a result, only minor processing, e.g., using deionization resin beds or reverse osmosis, is needed to restore the water to its initial purity and allow it to be reused for additional rinse operations. The reuse of deionized water will not only reduce filter cake volume from the RWTF but is also expected to improve deionized water quality and rinsing performance.

Another inorganic solid waste is from spent filters generated by the MFD EDM operations. EDM uses deionized water to cool the cutting wire and the part undergoing cutting. In-line filters remove metal particles from the deionized water and in-line resin beds remove dissolved metals from deionized water. The particle filters typically contain zinc and copper, the metals of the cutting wire, and metals from the parts, typically stainless steel and copper. The spent filters are not accepted by scrap metal recyclers due to their paper content. SLAC plans to pursue the manufacturer of the particle filters used in EDM operations to determine if these filters can be made attractive to metal recyclers by replacing with an alternative to paper.

EDM also uses resin beds to deionize the cooling water. The resin beds are recyclable. SLAC has spent much effort trying to obtain DTSC approval to have the resins recycled by a company outside the state of California. Difficulties were encountered when the company and SLAC tried to get clearance from the DTSC to send the spent resins to the company without a hazardous waste manifest.

Cyanide wastes, in the form of spent filters, also result in inorganic solid waste. The use of these filters will be reduced through a ROI project funded by DOE-OAK. This project has been implemented in 1996 and should show reductions in 1997.

5.2.3 Waste Oil, Mixed Oil, and Oily Solids (CWCs 221 and 223)

Currently, most oils collected from automotive, electrical, and various mechanical equipment are consolidated by WM and sent to a permitted off-site recycling facility. For automotive applications, SLAC is also considering procuring recycled oil to complete the recycle loop. The major barrier at this time appears to be that the price of recycled oils is still not competitive with virgin oil product based on SLAC and federal procurement guidelines.

Three source reduction measures to consider for reducing oil are: (1) recording equipment maintenance and oil changes, (2) sharing equipment between departments and (3) purchasing new equipment such as a vacuum pump with oil-free seals. For the first measure, departments already keep a close review of equipment operation and performance as part of standard operating procedures. Oil changes are usually at manufacturer-recommended schedules.

The second measure may be applicable in cases where operations can be consolidated. This is less probable for large-scale, fixed compressor or pump stations but may be acceptable for portable, small-scale equipment. The third measure becomes more attractive as older equipment nears the end of its lifetime. At that point an engineer or researcher may consider a new system that can eliminate the need for oil, e.g., pump with oil-free seals. In vacuum applications, an oil-free vacuum pump may have additional advantages that can increase the rate of payback of a new pump. An oil-free pump can decrease equipment cleaning and labor costs by reducing the probability of oil contamination in systems that require vacuum conditions. Acquisition of such equipment is dependent on available funds.

As mentioned earlier, SLAC has been able to reduce oil waste at the source by using synthetic oils in some pumps. Synthetic oils can have a longer operating life than conventional petroleum oils thus reducing the frequency of oil change without causing significant penalty to recycling options. However, the use of a synthetic oil requires equipment manufacturer guidance and endorsement of such oils to maintain equipment warranties and operating performance.

Unspecified Oil-Containing Waste or oily solids (CWC 223) generated in MFD’s machining operations may be include the following reduction measures:

- Removal of oil around machines by vacuum rather than totally relying on absorbents
- Reuse of partially used absorbents
- Additional training for machine shop areas on potential oily solid reduction practices
- Continuing collection of scrap metal from machine and pipe threading operations to remove free flowing oil

5.2.4 Empty Containers (CWCs 512 and 513)

Empty metal containers less than 30 gallons (CWC 513) are generated by numerous operations and are close to being a major waste stream (4.9 percent of the total routine hazardous waste). Chemicals such as alcohols, non-halogenated solvents, and fuels are packaged in 5-gallon metal containers. Under Title 22 California Code of Regulations (CCR) Section 66261.7, these containers, when properly emptied (i.e., no contents will pour out when the container is turned in any orientation) are considered non-hazardous and may be disposed as a non-hazardous waste or metal scrap. Such containers can be crushed to reduce waste volume without being considered treatment of hazardous waste. The crushed containers will have reduced volume and can be handled as metal scrap or as hazardous waste. SLAC's generators can be instructed on container emptying procedures. Such containers can be handled and centrally managed by WM to check that the containers are properly emptied, crushed, and transferred to SLAC's salvaging operations. Procedures are needed to assure that containers are properly managed. Such procedures were prepared and implemented in 1996.

5.2.5 Acids without and with Metals (CWCs 791 and 792)

Liquids or acids pH < or = 2 without and with metals (CWCs 791 and 792) are typically from metal cleaning and etching operations. Metal Finishing will investigate technologies to concentrate and purify these acids by a combination of evaporation and metal recovery or electrowinning techniques.

For acids from the cleaning of copper lines with detergent-phosphoric acid mixture (flushing agent), alternatives to reduce this waste will included the following:

- Reuse in multiple LCW system cleanings
- Addition of a LCW deoxygenation system

- Pursuing permit-by-rule (PBR) or conditional authority to treat under DTSC's tiered permitting system

SLAC was able to apply other alternatives that have used the preferred measures of source reduction or on-site recycling. Reusing a flushing agent for cleanings of multiple LCW system is an example of source reduction. Reuse of the flushing agent is possible when it has remaining strength. A limitation to this measure is the ability to schedule multiple cleaning back-to-back. However, SLAC will use this alternative where practicable.

The effectiveness of a LCW deoxygenation system has not been determined as mentioned earlier. SLAC will pursue PBR as an option to further reduce this waste stream.

5.3 Low Level Radioactive and Mixed Wastes

The general measures that SLAC proposes for reduction of low level radioactive waste are:

- Increase employee awareness and training on handling and segregation of materials transferred in or out of RMMAs to prevent unneeded generation of low level radioactive waste. This measure provides the additional benefit of reducing the number of items to be surveyed for radioactivity.

- Implement measures to survey and separate equipment or materials in decommissioning or maintenance/replacement activities by disassembling or physically cutting materials or equipment to separate low level radioactive from nonradioactive items.

Mixed waste is characterized as both radioactive and hazardous. The general waste reduction measures that SLAC proposes for reduction of low level mixed waste are:

- Increase employee awareness and training on identifying, handling and segregating hazardous materials transferred in or out of RMMAs

- Increase employee awareness in selecting less hazardous alternatives to replace hazardous materials.

Reuse of radioactive contaminated material or disposing of it as nonradioactive requires cooperation among DOE, federal regulatory agencies, the Nuclear Regulatory Commission (NRC) and EPA, and state agencies. DOE is developing a policy for recycling its own contaminated radioactive material, particularly, scrap metal, for internal use. Also, DOE is determining the limits for release and the survey techniques to support this policy. DOE will seek consensus with NRC and EPA on acceptable levels and techniques.

Under DOE Order 5400.5, DOE could seek release of material containing residual contamination into the public domain. Release of materials into the public domain when acceptable is a useful option since DOE operations may not be able to accommodate the quantities of scrap metal available for recycling. Both DOE Order 5400.5 and the proposed federal rule in Title 10 Code of Federal Regulations Section 834 grant DOE this option.

5.4 Toxic Chemicals

To replace trichloroethane or to further reduce its usage, SLAC has implemented three methods for reducing trichloroethane usage:

- Consolidating vapor degreasing with trichloroethane into one new closed-loop vapor degreasing system designed to recycle trichloroethane and significantly reduce its release to the atmosphere

- Replacing the present use of trichloroethane with a combustible petroleum distillate-based solvent and investigating on-site recycling to increase solvent reuse

- Cleaning klystron tubes assemblies by a combination of a spray-on, citrus-based solvent followed by steam-detergent wash and deionized water rinse

The first method is critical to SLAC's stringent cleaning needs for ultrahigh vacuum parts and has been selected over other cleaning alternatives to assure reliability in cleaning of a vast range of parts that are subject to ultrahigh vacuum. The second method helps reduce the use of trichloroethane in less critical cleaning operations. The third method uses aqueous cleaning for a common line of parts, thus reducing the dependence on trichloroethane. SLAC is currently implementing the second and third methods. Implementation of the first method is in progress. SLAC has procured the closed-system vapor degreaser and will be installing and testing it in the next couple of years.

6. Evaluation of Pollution Prevention Activities to Achieve Goals

6.1 Nonhazardous Waste

SLAC has achieved as high as 26 percent recycling of cardboard, office papers, beverage containers and garden waste. Based on a survey by SLAC and LLNL of SLAC municipal waste in site dumpsters in December 1996, most of the waste included bathroom paper towels, food wastes, and recyclable cardboard and paper. It is estimated that recycled paper and cardboard constitute about 30 tons or 5 percent of the total waste disposed to landfill. Assuming SLAC could add this quantity to it existing quantity of recycled materials, SLAC can achieve 30 percent recycling excluding scrap metals. SLAC scrap metal recycling has been variable; however, assuming a comparable generation of scrap metal in future years similar to 1996, SLAC may achieve 55 percent recycling of nonhazardous waste. This also excludes nonroutine wastes such as the concrete blocks that were recycled in 1995 (previously discussed in Section 2).

As mentioned earlier, SLAC will be implementing a pilot program to test the feasibility of a new recycling program in which SLAC owns its own collection containers and changes the technique in which recycled materials are collected in and removed from the containers. The pilot program and possible new recycling program is currently SLAC's best option for achieving nonhazardous waste reduction since there is a potential cost saving as well.

Additional efforts will be attempted to increase employee participation in double-sided copying as potential source reduction technique; however, no goals can be set for paper reduction by this technique since it is not readily measurable. SLAC will keep pursuing affirmative procurement of recycled products. Recycled paper use is currently at 50 percent level and may be moderately increased to 60 percent. One hundred percent usage of recycled paper is not expected to be achieved because of the diversity of copying machines around the site; however, some improved usage of recycled paper is expected by increasing employee awareness. Re-refined oil usage will continue to be pursued for automotive applications by keeping on watch for re-refined oil pricing that is competitively priced with new oil product.

6.2 Hazardous Waste

Based on the potential waste reductions summarized in Table 8, it is estimated that SLAC will meet a waste reduction of approximately 20,000 kilograms (22 tons) in 1996 operational hazardous waste for the major waste streams by the following measures:

- Reusing waste acids with and without metals by treatment under PBR and acid reuse (CWCs 791 and 792)

- Reducing rinse water usage in Metal Finishing to reduce heavy metal filter cake by reusing deionized water (CWC 181)

- Implementing measures to reduce waste oil and unspecified oil-containing wastes or oily solids by reduced use of absorbents (CWCs 221 and 223)

- Recycling empty containers as scrap metal (CWCs 512 and 513)

It is strongly emphasized that the suggested reductions in operational hazardous waste are based on 1996 waste generation trends. The 20,000-kilogram reduction will try to be achieved for the year 2000. The overall percent reduction in operational hazardous waste relative to the 1993 baseline will allow SLAC to achieve an overall reduction of 56 percent. As mentioned in Section 3 (Site Goals and Performance Measures), SLAC achievement of numerical waste reduction goals or performance objectives may not be attainable without compensation for nonroutine wastes or waste resulting from outside activities.

An evaluation of source reduction measures for the waste streams and measures discussed in the previous sections is provided in Tables 9 through 15. The evaluation methodology used is a simple 3-point rating system to identify probability of a given measure as low, moderate, or high in allowing consideration and implementation of the several items identified in SB 14.

Evaluation of waste reduction opportunities for these major waste streams are summarized as follows:

Alkaline Cleaning Solutions Without Metals (CWC 122)

This waste stream is generated by Metal Finishing. Reduction of this waste stream will be addressed mainly by continued monitoring and care to preserve bath life, and by treatment in the RWTF when the cleaner has reached the end of its useful life. This treatment measure has been selected because review of this waste stream's characteristics show that it is not hazardous. This alternative was also selected because SLAC has already implemented measures to increase the life of these solutions. An additional technology that is also being considered is the purification of the alkaline cleaners by continuous removal of oil using a permeable membrane. The system can be used in a closed loop with the cleaning bath to assure complete reclamation and exemption from hazardous waste control permits.

Liquid Cyanide Waste and Inorganic Solid Waste (CWCs 181 and 711)

This waste stream is generated by Metal Finishing. The approach to consider for source reduction of cyanide waste is a process change; however, a preliminary evaluation indicates that this measure may not readily apply to SLAC's needs. Process change would be most effective if it applied to the copper cyanide baths since they are the ones used in greatest quantity compared with other cyanide baths (gold or silver). Since the standards required for plating of some of the specialty parts at SLAC specify the use of these baths, a parallel test program have been performed to test the technical feasibility of alternate, non-cyanide baths. No alternative have been found to be successful at this time; however, additional testing may be considered in the future where feasible and based on new developments.

Inorganic Solid Waste (CWC 181)

Reduction of this waste stream will be accomplished mainly by reducing rinse water usage and in turn filter cake generation in the RWTF. Measures are in progress or have been implemented by Metal Finishing to increase the life of plating plates, to reduce generation of plating bath filters, and to reuse acids with and without metals. Reuse of deionized water is a measure that is currently in progress to reduce inorganic solids in the form of filter cake. This measure will be fully implemented in 1997.

Waste reduction options for EDM filters will be investigated by discussing alternative with MFD and filter manufacturers.

Waste Oil and Mixed Oil (CWC 221)

Currently the most feasible approach appears to be an administrative strategy of training employees and making them aware of measures to (1) reduce spillage, (2) segregate wastes, and (3) reuse materials that would otherwise become waste. Where technically and economically feasible SLAC may consider measures such as sharing portable equipment between departments and procuring new equipment such as a vacuum pump with oil-free seals (based on technical needs and available funding). The Geomatrix Report (Reference 7) also helped provide some direction in regard to reducing waste oil disposal in KLY operations. This will be further reviewed with KLY to determine implementability.

Unspecified Oil-Containing Waste (CWC 223)

Measures to increase employee training as previously mentioned for waste oil and mixed oil will also considered. The Geomatrix Report also identified measures to reduce the use of oil absorbents as a waste reduction technique.

Aqueous Solutions with Metals (CWC 132), Liquids with pH < or = 2 (CWC 791)

and Liquids with pH < or = 2 with Metals (CWC 792)
The main approaches to reducing these waste streams in Metal Finishing are by monitoring baths to avoid unnecessary contamination and increase the bath's useful life. SLAC is currently implementing measures to reuse acids. In the cleaning of copper LCW cooling systems, reuse of the flushing agent will be continued as a source reduction measure. Additional efforts to reduce acid waste will be pursued in both Metal Finishing and LCW cleaning operations by obtaining PBR.

6.3 Low Level Radioactive and Mixed Wastes

As discussed earlier, depending on their condition and the radiological characteristics, some of the metals may be ideal candidates to return to the environment for reuse because radioactive levels are extremely low and may qualify for exemption from regulatory control. This waste reduction approach is currently being developed between SLAC and DOE-OAK. However, it is not appropriate and too early to define goals for this waste stream at this time.

6.4 Toxic Chemicals

Using a combination of measures, it is estimated that SLAC will reduce the release and off-site transfer of trichloroethane by 80% in the next three years relative to 1993.

No numerical goals have been set for other toxic chemicals used at SLAC; however, SLAC is continuing to increase:

- User/generator training to increase employee awareness and guidance on considering less toxic alternatives

- Communication among the ES&H Division, Purchasing Department, and chemical users to help identify less toxic alternatives before the project or procurement process begins.

7. Resources and Timetables

A timetable for implementation of the measures discussed in this plan are provided in Figures 15 and 16. Based on the waste reduction measures to be implemented and comparable funding to earlier years, it is estimated that SLAC will meet an overall nonhazardous waste reduction goal of 55 percent and a hazardous waste reduction of 56 percent relative to the 1993 baseline. SLAC is planning to reduce low level radioactive waste by scrap metal recycling through a DOE-OAK-funded ROI project. Goals have not been set for this waste stream.

8. References

1. SLAC, Waste Minimization Program Plan to Comply with DOE Order 5400.1, November 30, 1994, SLAC-I-3A08A-001 Rev. 2)

2. SLAC, Waste Minimization Program Plan to Comply with California's Hazardous Waste Source Reduction and Management Review Act of 1989, October 31, 1995, SLAC-I750-308A-003

3. SLAC, Low-level Radioactive Waste Certification Program, SLAC-I-760-0A30M-001

4. SLAC, Radioactive Material Management Manual, SLAC-I-760-0A30Z-001

5. SLAC, Radioactive Waste Minimization Program at the Stanford Linear Accelerator, Draft, August 1995

6. SLAC, Environment, Safety, and Health Manual, ESH-100, SLAC-I-720-70100-100

7. Geomatrix Consultants, Final Report, Development of Waste Minimization and Pollution Prevention Opportunities, June 1996

TABLES

FIGURES

APPENDICES

Appendix 1Site Map (Aerial Photograph)

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Appendix 2Site Map - Municipal Waste and Recycling Container Locations

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Appendix 3Pilot Recycling Project

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Project Description
In cooperation with Stanford University's recycling program, SLAC has been recycling cardboard, various paper products, and beverage containers since the late 1980s. A summary of the recycling performance of the program from 1990 to 1995 is provided in Table 1. Although SLAC has achieved good recycling performance, it is not without cost. Subcontractor services for handling recycled materials have increased in recent years due to the labor of emptying collection containers in over 50 in-building locations around the site. SLAC is currently charged $20,000 per year for this service. SLAC does not receive a rebate on the recovered recyclable materials.

SLAC currently uses containers for collecting recyclables that are supplied and owned by the subcontractor. As a result, SLAC cannot competitively bid among numerous recycle subcontractors for alternative services since substantial efforts are required to replace collection containers if an alternative subcontractor is used. Based on reviews with potential subcontractors, advantage is realized if SLAC owns its own containers. Ownership of the collection containers helps keep the collection locations established and easy to find by employees. Also, SLAC can more readily perform competitive bidding for recycling services and have flexibility to use more than one subcontractor to service and to offer rebate for a particular recyclable material. Thus if one recycle subcontractor is offering a better services for cardboard, SLAC can competitively bid on cardboard collection services rather than being limited to one subcontractor who offers less competitive services for cardboard.

SLAC proposes to implement a new recycling program. This program will have the following elements:

- SLAC will own its own collection containers.
- Employee participation is expected by their using desktop collection containers and by their emptying of the desk top containers at a nearby in-building collection container location.
- Janitorial staff will consolidate in-building collection container contents and move the containers to locations outside the buildings.
- Containers outside of the buildings will be emptied by the recycling subcontractor (at no charge to SLAC).
- SLAC will receive a rebate from the subcontractor for recyclable materials collected.
- Upkeep of old containers and locating of new containers will be performed by the janitorial staff and SLAC's Facilities Department

SLAC's ownership of the containers and modifications in the collection system are intended to reduce annual fees associated with the recycle subcontractor's containers and the subcontractor's labor to perform in-building collection services. The proposed program will eliminate the $20,000 labor cost charged by the subcontractor and will result in some additional labor cost due to use of janitorial services, estimated at $4,000. Janitorial services will be used for collection of recyclables within the buildings and for centralizing recyclables at assigned pickup points outside the buildings. The subcontractor will empty the containers outside the building at no charge to SLAC. The cost for SLAC to purchase its own containers for the new recycling program is estimated at $40,000. An estimate of the containers to be purchased for $40,000 is provided in Table 2. The pilot project will cover approximately 25 percent of the initial cost of containers for the new recycling program.

The new recycling program is expected to increase SLAC recycling collection quantity by 10 percent. The 10 percent increase is based on visual observation of materials found in the dumpsters in the existing recycling program. The materials found in the dumpsters are usually cardboard, newspaper, and mixed papers. Increased participation and awareness by employees as well as special bins for recycling of cardboard are expected to help eliminate the 10 percent of recyclables that are currently found in the dumpsters.

As shown in Table 3, this new program is expected to provide a 28 percent return on investment over the next 7 years and a 2.4 year payback. The return is based on a reduction in labor costs to $4,000 to cover janitorial services and elimination of the $20,000 labor charge by the subcontractor. It is also assumed that $1000 of the potential $2,000 per year rebate offered by the subcontractor will be used to pay janitorial costs. A 50 percent factor is used for the return received from the rebate to cover fluctuations in market prices.

Pilot Project

To develop the program and test its potential for return on investment, SLAC would like to make an initial purchase of containers and use these containers to perform a pilot project with a recycling subcontractor. The purchase of containers for the pilot project is estimated at $17,000. An itemization by locations and container types is provided in Table 4. The purchase of containers for the pilot project is expected to pay for approximately 25 percent of the initial purchase of containers for the new recycling program.

The pilot project will allow SLAC to:

- test the types of collection containers used for recycling
- identify future recycle container needs for expanding the new recycling program
- take ownership of its own recycling containers
- develop employee participation and janitorial services for collection of recyclables

The pilot project will test the use of janitorial services for collection of recyclables within the buildings and for centralizing recyclables at assigned locations outside the buildings to ready recyclables for pickup by the subcontractor. The pilot project will also test employee involvement in collection of recyclable paper in desktop boxes and taking the contents of these boxes to collection points within the buildings. Special outdoor bins for collection of cardboard will also be tested to determine if they can be used to enhance separation of cardboard from trash.

The pilot project is expected to occur over a period of three to six months. It will be addressed in phases using the following buildings:

- Phase 1 A&E Building
- Phase 2 Building 24 (ES&H and ECD) and Building 50 (SCS)
- Phase 3 Building 44 (KLY), Building 40 (Central Lab), and the Cafeteria

Preliminary contact has been made with some of the Building Managers to make them aware of modifications to the existing program. PUR, EPR, and FAC Departments will be working with the subcontractor during this pilot project to modify the set up and labeling of collection locations, provide employee education, and monitor project performance.

Project Budget in FY97:

Capital Cost: Pilot Project Collection Containers	$11,930
Indirect Cost (G&A):	5,070
Subtotal	$17,000

Project Type: Recycling of Nonhazardous Materials, Pilot Project

Milestone Schedule:

Equipment Procurement	January 1997
Pilot Project Implementation	February 1997
Pilot Project Evaluation	August 1997
Implement New Recycling Program	October 1997